nothing more inopportune or noxious than the operation of purgative medicine within the period specified. The exaggerated peristaltic movements of the alimentary canal, which purging implies, are well calculated to awaken inflammation in the peritoneal membrane, to which a strong predisposition already exists, growing out of all the circumstances that so recently preceded, whilst the requisition made upon the abdominal muscles for their active co-operation, must necessarily interfere with the healing of the external wound, and might probably displace the ligature of the pedicle, giving rise to secondary hemorrhage. The recovery of both of my patients without a single untoward symptom, I am disposed to attribute more to the free use of opium, than to any other means that were employed, not excepting the genial and equable temperature which it was sought to maintain in their chambers.

But I have been wandering from the point. Dr. McDowell, as it appears from Dr. Goldsmith's testimony, was in the habit of giving his ovariotomy patients large doses of laudanum, and it is reasonable to suppose that his practice was designed to secure the ends, and ward off the dangers which we have been considering. If this be so, it exhibits him to us as being far in advance of his contemporaries in therapeutics, as well as in surgery, for they, as a general rule, knew of no other preventive of inflammation than low diet and purging, and no other remedy for the disease, when developed, than bloodletting, in copious effusions. Indeed, at that time, bloodletting was most rampant under the teaching of Dr. Rush, whose fame was then in its zenith, and whose eloquent voice and pen invested the lancet with irresistible charms.

ART. V.—*Notes upon the Effect of Alcohol, Glycerine, Water, Gum, Ammonia, and the Vacuum upon the Exposed Hearts of Frogs, Snapping-Turtles, and Sturgeons.* By S. W. MITCHELL, M.D., Lecturer on Physiology in the Philadelphia Medical Association. (Read before the Academy of Natural Sciences, Biological Department, December 20, 1858. Recommended for publication Feb. 22, 1859.)

IT is a matter of some interest as connected with the subject of the cause of the rhythmical action of the heart, to ascertain the effect of a vacuum upon its movements. At one time it was alleged that the contact of the air with the exposed heart was the stimulus which, under these circumstances, sustained its action. The simple experiment of placing the organ in vacuo to test the validity of this opinion was resorted to at various periods by Caldani, Wernlein, Kurschner, and John Reid, all of whom observed that the hearts of animals continued to pulsate in vacuo. On the other hand, Tiedemann, Fontana, and Dr. T. H. Bache and myself, found that the heart in vacuo always fell off in activity, and, in most cases, when the exhaustion was complete, ceased to pulsate.

In certain experiments made by Dr. Bache and myself we found, as just stated, that the hearts of frogs and snappers always became less active in vacuo. Not all of these hearts, however, could be made to stop suddenly when a rapid vacuum was effected, and some continued to pulsate in vacuo for upwards of half an hour. Since, however, the frog heart will pulsate in the air for many hours when suspended, and not disturbed, the effect of the vacuum becomes in all cases sufficiently plain. Thus, when the heart of a snapper, beating in the air fourteen times per minute, was suspended in vacuo, the pulse fell to four per minute, and so continued during twelve successive minutes, acting, however, very laboriously, a single pulsation occupying as much as ten seconds.

On readmitting the air, the pulsations rose at once to nine per minute, and on applying moisture in the form of blood, to eleven per minute. This heart remaining in the air ceased to pulsate at the end of an hour and eight minutes. The single experiment just stated illustrates well enough what usually took place when either frog or turtle hearts were thus treated. The number of pulses always lessened. Sometimes the heart stopped suddenly, beating anew when the air was let in on it, and in all cases exposure in vacuo, even for a time, shortened the length of the period during which the heart ordinarily continues to pulsate. I repeated these experiments in 1854, with like results, and was disposed to conclude that the mere absence of air certainly lessened the activity of the exposed heart. Observing, however, the laboured nature of each pulsation, as well as the swollen and distorted appearance of the heart in vacuo, it appeared to me that other elements were affecting the heart besides the mere absence of aërial stimulus. In despite of every precaution the exhaustion causes bubbles of air to appear under the pericardial surface, and evidently has a great mechanical effect upon the organ, producing blotches and dark stains, as of effused blood, upon the surface of the heart.

To learn, therefore, whether the effect is due only to the absence of atmospheric air, or in part to other causes, I suspended the hearts of several frogs and snappers in bland fluids, as oil, glycerine, and water at various temperatures.

Experiment.—The heart of a large turtle (wt. 12 lbs.) was removed with care. Suspended in air it beat, during four consecutive minutes, thus, 5½, 8, 8, 8. In vacuo, as complete as it could be made with a not very perfect pump which had no gauge, it beat, per minute, 3, 2, 3, 2, 2, 2, 1, 1, 1. The air being let in it rose to 3, 6, 7½, 7, 7, 7. Without moving the heart, a small glass of water, at 66°, was carried up from below, so that the suspended heart rested in it; or, as in this case, being weighed down by a half bullet, sunk below the surface. The heart instantly began to beat, strongly at first, and then feebly, its movements becoming more numerous, as thus:

1st m. 9; 2d m. 11; 3d m. 14; 4th m. 14; 5th m. 21, and very feeble. Two minutes elapsed without further movements, until being removed to the air it beat 11 the 1st minute, when the heart was placed in water at 113° F. Its pulse rose at once to 44, 1st minute, and 60, the 2d minute; then beat convulsively, and suddenly ceased. In air it again pulsated after several minutes, beating 5 regularly. The water at 113° F. again partially renewed its motions, which, however, were only 8 per minute, and altogether auricular, continuing through but four successive minutes.

Similar results attended nine experiments upon the effect of water at the temperature of the air, and at 113° F. In every case the water at aërial temperature quickened, and at last enfeebled and checked the heart's action. Water at 113° F. enormously accelerated the heart's movement, instantly sending it up to 20, 30, or even 88 to 120 pulses per minute, and always more or less convulsing its action. It is worthy of notice that, whether the heart be checked by hot or cold water, it is still susceptible of being restimulated by suspension in alcohol or by mechanical irritants.

I have made no similar experiments with mammalian hearts, but I have obtained precisely the same results with the large heart of the sturgeon, as is illustrated in the following experiment:—

Experiment.—The heart of a sturgeon, nearly five feet long, was removed as rapidly as possible, and allowed to expel all the blood from its cavities. It was then suspended in water at 70° F., the temperature of the air. After extraction it beat 33 per m. The water almost immediately accelerated its rate to 60 in the half minute, when it suddenly ceased to beat. Removed from the water and inflated with air it as suddenly began to act again at the close of twenty minutes. The air was then let out, and the heart plunged anew in water at 113° F. Several rapid pulses took place, and it ceased instantly. The effect of alcohol was not essayed.

From these experiments the power of water to stimulate the heart in certain animals is very well seen. The practical physician will at once be reminded of the stimulant effects of a too watery blood upon the human organ.

The action of an elevated temperature upon the heart is also of some interest.

The most important deduction, however, is the constant fact, that when the heart ceases to respond to one stimulus it may still be alive to others. This was further developed in very numerous experiments upon the effect of carbonic acid, nitrogen, ether vapour, and the vacuum, on the heart. Thus, the heart which ceased to act in vacuo again pulsated in air or water, and, having ceased to act in water, was still awake to the stimulus of alcohol. Even after this the muscular fibres, and sometimes the whole auricle, could be restimulated by the knife or a sharp tap. After stimulation by ammonia the heart could not be excited by any irritant. This fact, as well as the directly stimulating power of ammonia on the heart, are well seen in the following experiment:—

Experiment.—Temperature of air 70° F. A frog's heart beating steadily 27 per minute, was suspended over strong ammonia water. The organ instantly multiplied its pulsations, and, during six successive minutes, performed as follows: 44, 28, 32, 58, 36, 34, and suddenly ceased to act. Alcohol and mechanical means alike failed to re-excite its movement.

It was clear from the experiments stated that water at all temperatures affected the heart. My ultimate object was to make for the heart a practical vacuum by plunging it in a fluid which should not disturb it mechanically, and should simply shut out the air, and itself exert no stimulant influence. As pure water did not fulfil these ends I resorted to a solution of gum Arabic in water, sp. gr. 1.036.

Experiment.—The heart of the frog used in this experiment beat when taken out but nine in the minute. In fact, the hearts of frogs beat so differently as to number that it is always necessary to wait until the beat becomes regular through several successive minutes. The heart in question was plunged in a solution of gum, 1.036, temp. 70° F. It continued to pulsate nine times per minute during twelve successive minutes. A second heart furnished a result very nearly similar, the heart making fourteen beats in air and seventeen in gum water.

Pure glycerine was found, quite unexpectedly, to exert a depressing effect upon the heart. The results obtained may be briefly stated as follows:—

Experiment.—The heart of a frog in air, temperature 72° F., beat in successive minutes 36, 34, 30, 32; in glycerine 10, 14, 14, 13, 14, 14, and so continued to act unchanged for one hour, when it ceased to move. In a second experiment the heart beat unchanged in glycerine, but ceased to act at the close of seventy-eight minutes. Like results were observed in four similar experiments, so that the first one stated must be regarded as exceptional.

Glycerine, at a temperature of 100° F., acted as follows: A frog heart in air, at 71° F., settled to a regular pulse of thirty-four per minute. In glycerine, at 100° F., it beat in successive minutes 40, 52, 55, and ceased to act at the close of three minutes.

Glycerine at 32° F. rapidly depressed the heart's action. A heart beating forty in air at 70° F., fell at once in glycerine at 32° F. to 22, 21, 14, 14, 6, in successive minutes, and then stopped permanently. Several other experiments gave the same result, the heart rarely acting longer than five minutes.

Of all the agents used, olive oil gave the best results.

A frog heart, beating nineteen per minute at 72° F. in air, was suspended in neutral olive oil at 72° F. It underwent no change as to number or force for two hours, when it beat more feebly, and ceased to act in three hours and twelve minutes. In two additional experiments the heart gained one or two pulses per minute in the oil, continuing in one case for one hour and four minutes, in another for four hours and a half. Olive oil at 32° F. enfeebled the action, but did not affect the number of pulses, which could be readily observed during twenty minutes, when they ceased abruptly.

The effect of olive oil at aërial temperature was most admirably shown in the following experiment, which was designed to imitate closely the mechanical conditions existent during life, and, at the same time, to cut off from the heart the stimulus of the air.

Experiment.—The heart of a large sturgeon was rapidly removed at 8.30 A. M. As very often happens, it did not pulsate until it was hung up and inflated by means of a tube tied in the mouth of the auricle, the bronchial vein being closed by a tube having a stopcock, and bent at an acute angle three and a half inches above the bulbus arteriosus. After the heart had acquired a pretty steady pulse of thirty-four per minute, a funnel with a tube six inches long was fitted tightly in the mouth of the auricle, the tube used for inflation being removed. About half way down the stem the funnel was made narrow, so that oil placed in the funnel would not descend too rapidly into the auricle. The heart beat less regularly as the air was allowed to escape; but, upon being slowly and carefully filled with oil by means of the funnel fitted in the auricular opening, the heart regained its regular pulse, the number rising to 33, 34, 36, and, finally, settling to 33 per minute, with some irregularities to which the extracted heart of the sturgeon is usually liable. The heart was next placed in oil, and weighed down below the surface by a piece of lead attached to the apex of the heart by means of a piece of silk and a fine cambric needle. Thus situated, the heart was isolated from the air, while the oil being supplied through the auricular funnel was driven through the organ, up the arterial bulb, and, finally, over the bend in the pipe, which allowed it to escape. Under these circumstances the pulsations slowly rose in twelve minutes to thirty-seven per minute, when they began to fall, and in one hour were but twenty-one to the minute. With now and then a pause of many minutes, the pulses continued for an hour longer. At this time I was obliged to leave, and, therefore, replaced the funnel with a short open tube, plunged its upper orifice below the surface of the oil, and turned the mouth of the escape-tube into the vessel in which the heart was balanced. The organ was thus enabled to feed itself. On my returning in two hours, the auricle alone was beating. Its pulsations could still be seen one hour and eighteen minutes later, their number being reduced to twelve per minute. Other occupations prevented me from carrying the observations further. At this time, the pulsations being feeble and auricular only, had lasted for some five and a half hours, and could hardly have endured at the utmost more than two hours longer. The heart of a second sturgeon removed an hour after the first one had been placed in oil, when inflated in the air, pulsated irregularly about forty per minute during eight hours, and more irregularly, and finally, in the auricle alone during nine hours longer. It is probable, therefore, that complete isolation from the air, although at first it did not alter the number of pulses, lessened their ultimate duration.

These experiments seem to justify the following conclusions:—

1st. That the hearts of the frog and turtle beat much less rapidly in vacuo, and sometimes cease to act until the air is readmitted. That the vacuum most probably retards the heart's action by the mechanical effects it induces as well as by depriving it of oxygen, since the beat in vacuo is long and laboured and the accelerating influence of the readmitted atmosphere is almost instantaneous.

2d. That mere isolation from the air, as by placing the heart in oil, does not alter the rate of the heart's movements for some time, but lessens their ultimate duration.

3d. That water at aërial temperatures stimulates the heart, and very soon causes it to cease to pulsate. That water at higher temperatures, as 100° F. to 113° F., produces much more rapidly the same results.

4th. That glycerine at aërial temperatures affects the heart but little except as shortening the time during which it continues to pulsate. That glycerine, at 32° F., depresses the heart's action, lessening the number of pulses per minute at least one-half, and soon checking its movements altogether.

5th. That olive oil at 32° F. affected the heart very little at first as to the number of beats per minute, but soon rendered them feeble, and finally stopped them, though at the close of a longer interval than was required by glycerine at the same temperature.[1]

6th. That when the heart has ceased to respond to one stimulus, however violent, it will usually remain sensitive to others apparently far less powerful.

ART. VI.—*Observations on the Colourless Blood-corpuscle.* By WILLIAM A. HAMMOND, M. D., Assistant Surgeon U. S. Army. (Read before the Academy of Natural Sciences of Philadelphia, Biological Department, February 7th, 1859. Recommended for publication, February 21st, 1859.)

THE white blood-corpuscle, whether we regard it as the first or intermediate stage in the development of the red disk, or admit that we are unable to designate its uses, is entitled to far more consideration from physiologists than has, until recently, been awarded to it. Of late, however, through the researches of Wharton Jones, Virchow, Bennett, and others, it has attracted more particularly the attention of biologists, and perhaps ere long we may be enabled to understand its use in the economy.

The object of the present paper is to aid somewhat in the elucidation of one or two points of interest connected with this body, the principal of which relates to its persistence in its normal form in dried blood.

At the last meeting of the Department it will be recollected that in answer to an inquiry by my friend Dr. Woodward, I stated I had been unable

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[1] The glycerine was thinner than the English glycerine (Price's) now in use, and altogether was a much less reliable article. For this reason I do not entirely trust the results observed when using glycerine.